CHEST Critical Care

Vasopressors Administration Through Midline Catheters

Experience From a Single Center

To the Editor:

Critically ill patients require secure access for the administration of IV medications and appropriate monitoring. Midline catheters are typically inserted into deep peripheral veins in the upper extremities (basilic, brachial, or cephalic)[1] and are used for blood draws, fluid resuscitation, and medication administration, including vasoactive agents.[2,3] Literature has shown that vasoactive agents may be administered peripherally through midline catheters for durations of up to 7 days.[3] The purpose of this study is to evaluate the utility and safety of midline catheters for administration of vasopressors in medical ICU (MICU) patients.

Methods

This is a single-center prospective observational quality assurance study to evaluate the utilization of midline catheters for administering vasopressors in the MICU at a university-based academic tertiary hospital. The use of midline catheter for all patients requiring durable venous access, including for vasopressor administration, is a protocolized practice in our MICU (Table 1). We reviewed all ultrasound-guided midline catheters consecutively inserted in adult patients from November 2019 to March 2020. This study was approved as a quality assurance study by the human subjects committee (Institutional Review Board #1511970-1) in October 2019.

The midline catheter was the unit of analysis. The electronic medical record was searched periodically during the study time period to identify midline catheters placed in the MICU. Catheter characteristics, including the vein accessed, vein caliber, catheter tip location, and length, were collected from procedure notes. Patient demographics, insertion site edema/anasarca, type of vasopressors, infusion dosage, concentration, total dose, duration, and catheter dwell time were collected from the electronic medical record. Adverse events were gathered from nursing and physician documentation. Major adverse events included bloodstream infection, tissue ischemia or necrosis, and limb endangerment. Minor adverse events included inability to aspirate blood from one or more ports, leaking, extravasation, ecchymosis, hematoma, accidental removal, or DVT. Leaking was defined as the presence of fluid at the catheter site because of soft tissue fluid draining through the tract formed by catheter placement. Extravasation was defined as the collection of administered medication outside of the intravascular space due to midline failure. Nurses were required to assess all midline catheters every 2 h to ensure blood return during infusion (Table 1). Any concerns about potential complications were reported immediately to the medical team and documented.

Categorical variables are reported as absolute frequency with percentage, and continuous parametric variables are reported as median and interquartile range (IQR) using IBM SPSS Version 28.0.

During the preparation of this work, we used ChatGPT for grammar checking. After using this tool, we reviewed and edited the content as needed and take full responsibility for the content of the publication.

Results

A total of 66 cases of vasopressor administration via midline catheters were included (Table 2). The most common insertion site was basilic vein (54.5%, n = 36), followed by brachial vein (27.3%, n = 18). Without tourniquet, the median caliber of the access vein was 3.9 mm (IQR, 3.0-5.0); with tourniquet, the median access vein diameter was 4.8 mm (IQR, 4.0-6.3). The median midline catheter length was 12 cm (IQR, 10-15). The median dwell time for the midline catheters was 7 days (IQR, 5-14).

Concurrent use of more than two vasoactive agents was seen in 24.2% of cases (n = 16). Norepinephrine was the most frequently administered vasopressor (95.4%, n = 63), followed by vasopressin (27.3%, n = 18), phenylephrine (10.6%, n = 7), and epinephrine (3%, n = 2). The mean norepinephrine equivalent[4] infusion rate through each catheter was 0.12 ± 0.19 mcg/kg/min. Total vasopressor dose, concentration, and mean infusion rate are listed in Table 3. Vasopressors were used for an average of 3.1 ± 3.38 days. The mean duration of concurrent use of vasopressors was 2.7 ± 1.2 days.

The most common adverse event was inability to aspirate from at least one port (59.1%, n = 39). Leaking occurred in 19.7% of cases (n = 13); of which 85% (n = 11) had generalized edema documented (Table 3). Ecchymosis was observed in 3% (n = 2), hematoma in 1.5% (n = 1), and accidental removal in 3% (n = 2). DVT of ipsilateral upper extremity to midline catheter insertion site occurred in 2% (n = 3), whereas 1.5% (n = 1) had both ipsilateral and contralateral upper extremity DVT. No bloodstream infection,

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TABLE 1] Dual Lumen Midline Catheter Best Practices Protocol

Equipment characteristics
- Dual lumen, length cut to 8-15 cm

Recommended procedural techniques include the following:
- Site selection by evaluation of both upper extremities; preferred site is cephalic vein if available
- Standard sterile technique
- Ultrasound guidance
- Confirmation with blood gas sample and/or modified echocardiographic bubble or flush study

Usage
- Dual lumen midline catheter is used for blood draws, infusions, and medications in accordance with standard protocols for central line utilization, including the following:
  1) All solutions/medications approved for administration via peripheral IV line
  2) Parenteral nutrition and other infuses with an osmolarity of ≤ 900 mOsm/L
  3) Hypertonic saline 3%
  4) Vasopressors with no specific restrictions, including no restrictions to infusion rate, concentration, or duration

Exceptions
1) Chemotherapeutic agents and corrosive fluids not approved for administration via peripheral IV catheter
2) Hypertonic saline (23.4%)
3) Total parenteral nutrition

Maintenance
- All infusions
  1) Flush with 10 mL 0.9% normal saline before and after each use, and every 12 h when not infusing
  2) Lock catheter with normal saline when not in use
  3) Dressing changes are performed every 7 d, or more frequently as needed, and should include the following:
     - Apply a chlorhexidine-impregnated sponge to the catheter-skin junction site, and change with each dressing change
     - Label date and time dressings were applied
  4) Avoid placing the BP cuff on the arm with midline catheter
  5) Notify the medical team promptly and document findings in electric medical record for any concerns
  6) If unexpected fluid is noted at the catheter entry site: stop infusion, check for blood return, and flush with 10 mL normal saline
     - If unable to flush, midline catheter is considered failed and will not be continued for use
     - If able to flush but unable to withdraw blood, physician will determine further use
  7) Midline catheter removal is determined by the clinical team, guided by the following general principles:
     - Midline catheter removal should be considered if there is erythema, skin discoloration, warmth or swelling at the insertion site, or if there are any signs of vascular compromise or a threatened limb
- During vasopressor use, additional maintenance should include the following:
  8) Check for blood return prior to start infusion
  9) Assess the access site and check for blood return every 2 h during infusion
     - During these checks, there is specific monitoring for signs/symptoms of leaking (ie collection of edema, anasarca fluid at skin entry site), extravasation of the ongoing infusion, or other potential complications (eg, catheter occlusion, vascular compromise, site infection, catheter migration)

extravasation, tissue injury, necrosis, loss of limb, or deaths were attributed to midline catheters. Furthermore, no major adverse events were observed when multiple vasopressors were simultaneously administered.

Discussion

In our institution, midline catheter usage is a protocolized practice, with standardized monitoring and documentation. Best practices derived from our approach to midline catheter use and maintenance are outlined in Table 1. Midline catheters are used for fluid resuscitation, vasopressors, and other medication administration, to substitute central venous catheters, except for chemotherapeutic agents, total parenteral nutrition, or 23.4% hypertonic saline. In this cohort, administering vasopressors through midline catheters did not result in major adverse events. Leaking was common, and most of these patients had generalized edema, which presumably contributed to local fluid buildup and leak from the insertion site. Although previous authors reported an extravasation rate of 6.9%,[5] we did not observe any extravasations. Based on our experience, we recommend close monitoring during infusion, including assessing the access site and checking for blood return every 2 h, and other facets of

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TABLE 2] Patient and Catheter Characteristics (N = 66)

Characteristic	Value
Age, y	68 (54-76)
Sex	
Male	43 (65.2)
Female	23 (34.8)
Height, cm	172 (160-180)
Weight, kg	85 (67-102)
Comorbidities	
Peripheral vascular disease	3 (4.5)
Diabetes mellitus	23 (34.8)
Hypertension	35 (53.0)
Chronic kidney disease	6 (9.1)
End-stage renal disease	4 (6.1)
Hyperlipidemia	18 (27.3)
Coronary artery disease	21 (31.8)
Heart failure	13 (19.7)
COPD	11 (16.7)
Atrial fibrillation	11 (16.7)
Valvular disease	1 (1.5)
Catheter type	
Dual lumen	62 (93.9)
Not documented	4 (6.1)
Vein Accessed	
Basilic	36 (54.5)
Brachial	18 (27.3)
Cephalic	7 (10.6)
Not documented	5 (7.5)
Catheter tip location	
Basilic	16 (24.2)
Axillary	8 (12.1)
Brachial	9 (13.6)
Cephalic	3 (4.5)
Not documented	30 (45.5)
Catheter dwell time, d	7 (5-14)
Catheter length, cm	12 (10-15)
Vein diameter, mm[a]	
Without tourniquet	3.9 (3.0-5.0)
With tourniquet	4.8 (4.0-6.3)
Change with tourniquet	0 (0-1.2)

Values are No. (%) or median (interquartile range).
[a]The vein diameter measurement was not documented in 45.5% of cases (n = 30).

maintenance care are to prevent such complications, as detailed in Table 1.

Previous studies recommended that the caliber of the catheter lumen should not exceed a catheter to vein ratio of 33%.[3,6] The outer diameter of the 5F Medcomp dual lumen midline catheter is 1.8 ± 0.1 mm. In our study, vein caliber sizes were generally smaller (median, 3.9 mm) with a catheter to vein ratio of 46%. Inability to aspirate blood return was commonly observed, and it is possible that a higher catheter to vein ratio than typically recommended could have played a role in this observation. In such situations, if a catheter can be flushed without resistance, physicians are required to evaluate and determine if midline catheters can continue to be used, via best practice guidelines provided in Table 1.

Although any dose of vasopressors was allowed to be administered through the midline catheter, in this cohort, the norepinephrine equivalent dose was at the lower range of usual norepinephrine doses for refractory shock.[7] The catheter dwell time was also shorter than the comparable cohort in the literature.[3] These observed trends may limit the generalizability of our findings. The retrospective single-center study nature of the work also leads to incomplete data surrounding vein characteristics, limiting our ability to make firm conclusion about the rule of vein caliber. Additionally, adverse events were assumed to have been concurrently reported and documented, and although we think that major adverse events would not have been missed on our thorough retrospective review of such documentation, it is unknowable as to whether minor events were missed. Nonetheless, we suggest that insertion as an alternative to central venous catheters for vasopressor administration is a potential safe and durable option, even when multiple vasopressors are needed.

In conclusion, our study did not detect any major adverse events associated with using midline catheters for vasopressors, even when multiple vasopressors were administered through midline catheters. Further studies are needed to investigate higher doses and longer duration of vasopressors via midline catheters, and to compare their safety and efficacy to other catheters in larger populations.

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TABLE 3] Vasopressor Characteristics and Adverse Events

Characteristic	All Catheters (N = 66)
Vasoactive agent use	
Norepinephrine	63 (95.4)
Vasopressin	18 (27.3)
Phenylephrine	7 (10.6)
Epinephrine	2 (3)
Multiple vasopressor agents	16 (24.2)
Total vasopressor dose	
Norepinephrine, mg	14 (3.1-30)
Vasopressin, unit	113 (53.9-227.8)
Phenylephrine, mg	256.8 (33.3-1079.8)
Epinephrine, mg	1.3 (0.6-1.3)
Total norepinephrine equivalent dose through each line, mcg/kg/min	0.12 ± 0.19 (0.02-1.28)
Mean infusion rate	
Norepinephrine, mcg/kg/min	0.04 (0.02-0.08)
Vasopressin, units/min	0.02 (0.01-0.03)
Phenylephrine, mcg/kg/min	0.76 (0.19-1.8)
Epinephrine, mcg/kg/min	0.53 (0.10-0.85)
Vasopressor concentration	
Norepinephrine, 16 mcg/250 mL	33 (50)
Norepinephrine, 8 mcg/250 mL	5 (7.5)
Norepinephrine, 4 mcg/250 mL	25 (37.8)
Vasopressin, 50 units/50 mL	18 (27.3)
Phenylephrine, 200 mcg/250 mL	3 (4.5)
Phenylephrine, 50 mg/250 mL	4 (6)
Epinephrine, 16 mg/250 mL	1 (1.5)
Epinephrine, 4 mg/250 mL	1 (1.5)
Individual vasopressor days	3.1 ± 3.38 (1-22)
Multiple vasopressor days	2.7 ± 1.2 (1-7)
Minor event	
Unable to aspirate from port	39 (59.1)
Leaking[a]	13 (19.7)
Extravasation	0 (0)
Ecchymosis	2 (3)
Hematoma	1 (1.5)
Accidental removal	2 (3)
DVT	3 (4.5)
Ipsilateral upper extremity DVT[b]	2 (3)
Bilateral upper extremity DVT	1 (1.5)
Major event	
Bloodstream infection	0
Tissue ischemia	0
Tissue necrosis	0
Limb endangerment or death related to midline catheter	0

(Continued)

TABLE 3] *(Continued)*

Values are No. (%), No., median (interquartile range), or mean ± SD (range). Norepinephrine equivalent = norepinephrine + epinephrine + phenylephrine/10 + vasopressin × 2.5 (all in mcg/kg/min, except vasopressin in units/min). Our institution uses non-weight-based infusion for all vasopressors. Mean infusion rate is calculated using total dose divided by weight and total infusion time (min) for each catheter.

[a]Of leaking cases, 85% (n = 11) had generalized edema or anasarca.

[b]Vessel diameters (without tourniquet) were 2.4 and 2.5 mm.

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None declared.

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